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H. B. WALKER, President | RAYMOND OLNEY, Secretary-Treasurer

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The Object and Scope of A. S. A. E. Activities

THE American Society of Agricultural Engineers was organized in December, 1907, at the University of Wisconsin by a group of instructors in agricultural engineering from several state agricultural colleges, who felt the need of an organization for the exchange of ideas and otherwise to promote the advancement of agricultural engineering. The object of the Society, as defined by the Constitution, is "to promote the art and science of engineering as applied to agriculture, the principal means of which shall be the holding of meetings for the presentation and discussion of professional papers and social intercourse, and the general dissemination of information by the publication and distribution of its papers, discussions, etc."

The membership of the Society represents all phases of agricultural engineering, including the educational, professional, industrial, and commercial fields.

The scope of the Society's activities embraces both the technical and economic phases of the application of engineering to agriculture, and is comprehended in the following general headings:

(a) Farm Power and Operating Equipment—power, implements, machines, and related equipment.
(b) Farm Structures—buildings and other structures and related equipment.
(c) Farm Sanitation—water supply; sewage disposal; lighting, heating, and ventilating of farm buildings, and related equipment.
(d) Land Reclamation—drainage, irrigation, land clearing, etc., and related structures and equipment.
(e) Educational—teaching, extension, and research methods, etc., employed in the agricultural engineering field.

Member American Engineering Council

AGRICULTURAL ENGINEERING

The Journal of Engineering as Applied to Agriculture

RAYMOND OLNEY, Editor

Vol. 6 FEBRUARY, 1925 No. 2

EDITORIALS

Horseless Farming

IT is but a few years ago when the man who predicted that horseless farming would be feasible inside of a generation was generally looked upon as a dreamer, or worse. As the farm tractor proved its efficiency. economy, and adaptability to a variety of farm operations, prevailing opinion swung to the point where it was believed that the tractor would displace horse power for the heavier farm operations, but it clung fast to the notion that some horses would always be needed on practically every farm. It may be said that this feeling is still quite general today.

In spite of the fact, however, that most farmers still believe that some horses are needed, even on the most completely equipped mechanical-power-operated farms there are instances of farmers who have displaced horses entirely even on farms where general farming is practiced. At a recent meeting of the American Society of Agricultural Engineers a young Iowa farmer related how he had been successfully operating a farm entirely without horses. He found that it was costing him $1,750.00 to maintain his ten work horses. He decided he could cut his power costs by substituting mechanical power. Today there is not a horse on his farm, as he has displaced them with two tractors, a motor cultivator, and a motor truck. He has found that not only has he been able to reduce materially his power costs for the same amount of work but his mechanical power equipment has enabled him to farm an additional area of land, thereby greatly increasing production with the same or less hired help.

This young man's experience is a very good example of the practical application of engineering to agriculture. One of the biggest problems with which the agricultural industry is faced today is to reduce the cost of agricultural production, and for the most part it is a problem for the agricultural engineer.

The experience of the young man just related is one that could be repeated today on a large percentage of the farms of the corn belt. It is the result of common sense and managerial ability that is not so rare among the better class of farmers. To most farmers it takes some courage to undertake displacing the use of horses entirely. but wherever it is feasible it is probably the surest road to larger profits from farming.

The time seems ripe for agricultural engineers, particularly those connected with the federal department of agriculture and land grant colleges and experiment stations, to undertake an extensive study of what successful farmers have accomplished in the way of adapting mechanical power efficiently and economically to a larger variety of farming operations. Certainly the methods employed by the young man whose experience has been related is well worthy of study. The same is true of a great many other farmers.

Agricultural engineers generally recognize that mechanical power is destined to displace muscle power in agriculture as it has done in transportation and the manufacturing industries. It would, of course, not be wise to unduly force this development by means of high-pressure publicity and promotional effort, but the agricultural engineer, through engineering studies, should be able to direct such development along sound economic and engineering lines.

Find the Facts

"FACTS are chiels that winna ding." Unrecognized facts have brought oceans of trouble and misery upon the human race. Kings puffed up in their own conceit have turned their blind side to popular advancement and growth and have thereby lost their crowns and their heads. Popes, bishops and prelates sightless through predjudice and false zeal have sent by thousands the forward looking men of their times to torture and death. Modern men have a smug, self-satisfied horror at the cruelty and ignorance of far off unhappy times, yet our modern usually has a hardy crop of likes, dislikes and preconceived notions which kill his perception of 1925 facts.

Take the tractor industry as an example. New tractors by the hundred were designed around some mechanical idea with scant analysis of what the farmer actually required in the business of farming, so millions in money and unmeasured mechanical endeavor have vanished into the air.

Every agricultural engineer should be a true fact seeker. "Prove all things and hold fast that which is good" should be his motto. He must beware of the insiduous inclination to accept as true any idea that gets into print. His problem is to conserve for the use of the race the natural resources of this earth. Soil erosion, waste of timber and fuel supplies, waste of the products of the fields, and above all waste of human effort are facts nd problems which dare him to be energetic and honest in his searchings after the truth of things.

WM. AITKENHEAD

Why Don't They Know?

DO we use every opportunity to tell the public that there is such a thing as agricultural engineering? Do we always let the people know, who are doing work which falls under one or more of the agricultural engineering classifications, that there is an American Society of Agricultural Engineers? In fact, how many people did you tell yesterday, last month, or last year that you were a member of A. S. A. E.

The Society is young and one of its greatest needs is publicity, what it is doing and what it can do for society. Advertising, "telling the world" about it, is the way to help make the Society grow and its work known and extended. Suppose that each member should stamp his letterheads with "Member American Society of Agricultural Engineers", or "Join the American Society of Agricultural Engineers". I firmly believe it would exert a wonderful influence in promoting agricultural engineering.

Rotary clubs, chambers of commerce, and many other or-organizatins use this and other methods of telling about their work.

In my attempts to organize the North Atlantic Section of the Society, I am surprised to find many people in this territory who ought to be members, but do not even know of the existance of such an organization. Evidently we have been "asleep at the switch" in this section. I would like to see a publicity committee appointed to work with the Secretary along this line. He can't do it all. He is overworked as it is.

Let's "tell the world" about it. Our development depends on you and I as A. S. A. E. members. We must not fail by the sins of omission. Let's go.

R. U. BLASINGAME

The Menace of Foreign Agricultural Competition*

By Arnold P. Yerkes

Mem. A. S. A. E. Editor "Tractor Farming", International Harvester Company

"THE characteristic and precious feature of American agriculture is its large production per man."

The foregoing statement is quoted from the yearbook of the U. S. Department of Agriculture for 1921. Its counterpart could probably be found in a thousand different publications.

"The American farmer leads the world in production per man" is a congratulatory phrase which has flowed easily and frequently off the pens of agricultural writers, and been equally popular with public speakers for the past quarter of a century.

And why not? It is a pleasing statement and one which no one has seen fit to question during all the years it has been used. In fact, it has been beyond question. Again quoting from the U. S. D. A. yearbook:

"Six and a half million farmers in the United States, assisted by a somewhat smaller number of farm laborers, probably less than 4 per cent of the farmers and farm laborers of the world, produce nearly 70 per cent of the world's corn 60 per cent of the world's cotton, 50 per cent of the world's tobacco, about 25 per cent of the world's oats and hay, 20 per cent of the world's wheat and flaxseed, 13 per cent of the world's barley, 7 per cent of the world's potatoes, and 5 per cent of the world's sugar. * * * * * * The average production of cereals per person engaged in agriculture in the United States is 12 tons, while for the rest of the world it is only about 1.4 tons."

On its face, that would seem like a record of which every one connected with American agriculture might well be proud. But success and efficiency are both relative. If we compare American farmers as a group with European peasants as a group, the American farmers are a very efficient and prosperous lot.

But if we compare individual farmers with the mathematical average, we find some are exceptionally successful, while thousands of others are decidely inefficient.

Furthermore, if we compare the progress made by American farmers with the achievements of American industrial workers, it is not so flattering.

It is less than one hundred and fifty years since the thirteen colonies became an independent nation, and in that short time, starting with practically nothing and competing against the workers of other nations with their established facilities for production, the industrial workers of this country have produced and accumulated wealth of all kinds which is at once a source of wonder and envy to other nations.

McGraw-Hill Company, in a recently published statement, show how completely we have changed from a dominantly agricultural nation to an industrial nation by the following figures indicating the sources of our national business income:

$61,000,000,000, or 54.5% from industry.
30,000,000,000, or 26.8% from the trade and service groups.
17,000,000,000, or 15.2% from agriculture.
4,000,000,000, or 3.6% from profesional service of all types.

They explain these figures as follows:

"The income of industry reflects its extensive use of mechanical equipment by showing a high productivity per worker. Business income produced per worker for the four groups classified above is in the following ratio:

Agriculture	$1.00
Professional	1.32
Trade and service	2.00
Industry	2.15

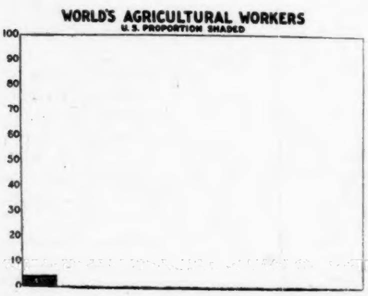
"The position of American industry today, as the leading world producing group has been gained almost exclusively by the application of mechanical methods to boost the limited production possible by hand work. Looking forward into the future, with particular regard to our present immigration restrictions, the path of industrial progress is obvious. American industry must go forward as never before through increased and more efficient 'machine' applications."

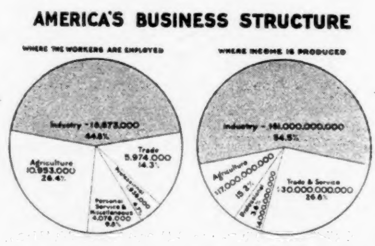
Surely no one can question this analysis, for its truth is apparent.

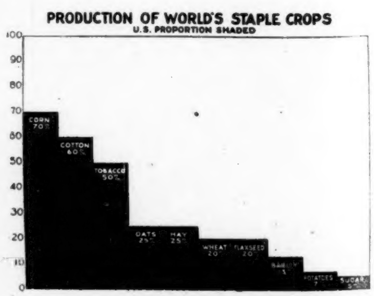
Now, if we seek the reasons why industrial workers have surpassed our agricultural workers in efficiency, we learn some facts which should be particularly significant to every agricultural engineer, though they are not flattering. The fundamental reason for the difference lies in the greater attention which has been given by industrial engineers to the saving of labor, and the results they have accomplished along this line.

So important and valuable were many of their efforts in this direction and so enthusiastic did many manufacturers become over their results, that a few years ago there developed a group of men who termed themselves "efficiency engineers", and who devoted their entire attention to the saving of labor by substituting improved machines and methods. So successful were many of the first engineers who entered this work, and so liberal was the remuneration paid by the manufacturers who profited by the tremendous savings frequently effected, and, furthermore, so great was the demand on the part of manufacturers for men who could show them how to cut their production costs, that

*Paper presented at the meeting of the Farm Power and Machinery Division of the American Society of Agricultural Engineers, Chicago, December 3, 1924.







The present status of foreign agricultural competition, and its prospects for future growth, is a real menace not only to American farmers but to the whole nation as well. It presents also a tremendously big problem that, for the most part, must be solved by the agricultural engineer. The agricultural engineer can and will solve the problem when the farmers, agricultural institutions — all agencies promoting agricultural development — give him a free hand to do the job in the way it must be done. But as in the case of manufacturing and transportation, the engineer will completely revolutionize and transform present day practices.

many men entered the profession who were not competent, and others extended their efforts to absurd lengths, until "efficiency engineering", under that name, fell into more or less disrepute.

However, the work is still carried on, under one name or another, and in many of our large industrial plants, the efficiency engineer, regardless of what he may be called, is the highest salaried technical worker on the roll, and rightly so because his work is more valuable than that of the chemists, mechanical engineers, designers, or other technical men.

It should be noted, too, that his work does not consist of designing new machines, except incidentally—his principal function is to be informed as to the most efficient tools and machines for different operations, to see that they are used wherever practical, and also to see that the operators are proficient in the use of each machine, so as to get the greatest possible benefit from it.

Very little work of this kind has been done for American agriculture except by the people who had machinery to sell. The need of it has frequently been recognized, and agricultural economists, farm management experts, and agricultural engineers have all claimed this work as belonging to their particular field, but none of them has met the need which was admitted to exist.

Had it been met, there would be less time and butter fat wasted by hand skimming, less time and manure wasted by spreading with a fork, less time wasted pumping water by hand and carrying it in buckets, less time wasted behind small teams pulling walking plows, one-row cultivators, small harrows, five-foot mowers, six-foot binders, and the many other inefficient tools used by the thousands on American farms, notwithstanding the fact that improved machines for all these purposes have been available to farmers for many years.

Comparatively few American farmers are working at anything like maximum efficiency—maximum efficiency in this case being assumed as the efficiency of those farmers producing the greatest amounts of crops per worker and at least cost per unit.

It is the inefficient majority that this society should be most interested—the efficient farmers probably need the help of the Society less than the Society need theirs.

It is not telling anything new to say that a great many farmers have been dissatisfied with the difference between their cost of production and their selling price while others have had no complaint. Why is this? It is not due to differences in weather, soils or selling price. The tariff doesn't explain it. Cooperative marketing doesn't explain it. "Diversification" doesn't explain it. Nor will any of the other cure-alls and panaceas explain it or remedy it if tried. The difference in profits has been due principally to differences in efficiency—when two men sell the same product at the same price and one makes a profit while the other loses money, it is obvious that the product must have cost one less than it cost the other.

And in farming, the difference in costs has been more largely due to differences in the amount of power used per worker than to any other one cause!

It is an axiom among maufacturers that when your competitor can afford to sell goods cheaper than you can, your costs must be too high. This is equally true of the farming business.

It is a well known fact that American manufacturers in many lines are today, and have been for years, successfully competing in foreign markets against products from other countries where labor is much cheaper, but where inefficient equipment requires so much labor, even at the low wages, as to make the cost of production higher than ours.

The one thing which American manufacturers have to fear more than any other is that foreign competitors might make use of shop equipment as efficient as that used in American plants. If, over night, European factories could install the same equipment which ours have, and their workers be trained to use these machines, the American manufacturers would wake tomorrow morning to find not only their foreign trade lost, but their domestic trade most seriously threatened. Such a condition would be a real calamity for us as a nation. Thus far our manufacturers have been successful in keeping in the lead in the matter of labor-saving equipment. And our industrial engineers must be given the credit for it. Their success has been acheived by making constant improvements in our factory equipment; they have encouraged in every way the invention of improved machines and have utilized them as they were produced. To put it in slang, the American manufacturer has constantly kept a "jump or two ahead" of his foreign competitors.

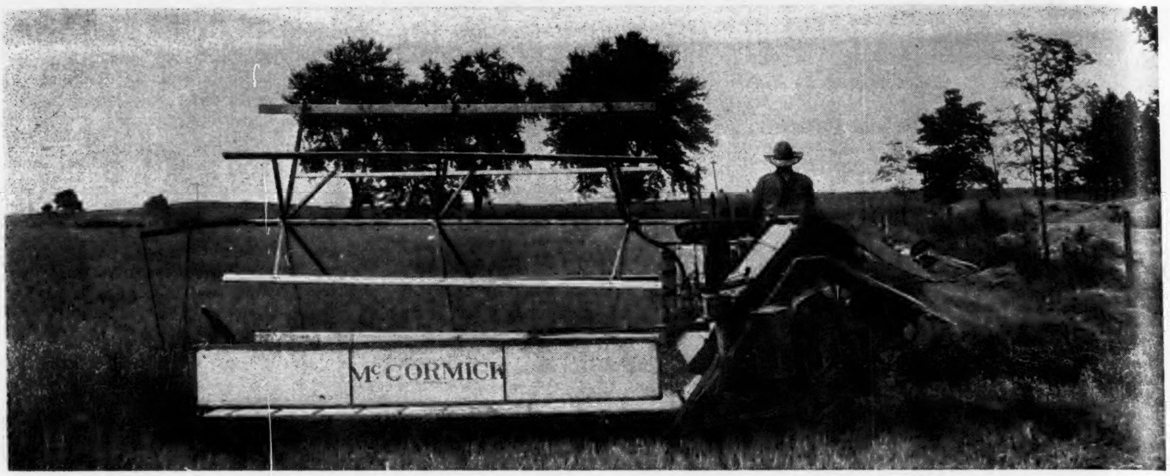
Representatives of foreign manufacturers have repeatedly made inspection tours of our factories to learn the reasons for our low production costs. They quickly saw that machinery was responsible for it and upon their return recommended the use of similar machines in their own plants. But, as often as not, by the time such machinery could be purchased, installed, and men trained to use it, the American manufacturer had devised still further improvements and even greater savings in cost.

Nothing succeeds like success, and in business competition it is much easier to keep ahead than it is to get ahead. Leading competitors reap the richest rewards, but, since their own example is a great help to those who are trying to catch up, leaders dare not stop progressing, for to do so means they will no longer be leaders. Such being true, every wise business man uses his advantages of superiority to maintain that superiority.

Has the American farmer done this? For many years, due to fortunate circumstances, he has been superior to farmers in other countries, as already shown. Has he consciously made any effort to maintain this superiority? Or, what is more pertinent, have the agencies which are supposed to act in an advisory capacity to him made any conscious efforts to help him maintain his superiority?

Of course much has been done to help him produce better crops and livestock, to obtain bigger yields and to maintain his soil fertility, but these are all points in which his foreign competitors have perhaps excelled, on the whole. In the most important line of all—that of increasing his labor efficiency—our educational agencies have done comparitively little, except in isolated instances—far less than similar agencies in foreign countries have been doing for his competitiors. And from this neglect of the factor which has been the American farmer's greatest asset, has arisen the greatest menace to his prosperity which he has ever faced.

The American farmer has been in the same relative position as the American manufacturer. For years he has been a large exporter of crops produced by machinery and sold in successful competition with similar crops produced by inefficient methods in other countries. He has never com-



The solution of the problem which the American farmer is facing in connection with foreign agricultural competition lies largely in more efficient, more extensive use of mechanical power and the most modern labor-saving farm machinery

peted to any extent with farmers who used equally efficient equipment and methods. And he has just as much to fear in this direction as the American manufacturer.

But the farmer has not used his advantage to maintain his superiority, as has the American manufacturer. Apparently he has not realized that he had any foreign competitors to fear, and no one has warned him of the almost irreparable mistake he was making in permitting his competitors to equal or surpass him in efficiency.

Yet common sense should tell us that other countries would not be likely to continue to buy our machine-grown crops when they could just as well buy the machines and produce the crops cheaper than our farmers could raise them. And common sense would also tell us that countries with an abundance of cheap, fertile land and the same desires to acquire wealth as we possess would not be slow to attempt to exploit their own resources to their profit and to our disadvantage.

Human nature is pretty much the same the world over. And capital is not limited by national boundaries! A nation possessing fertile land and an abundance of labor will have no trouble in obtaining capital, and quite likely American capital, to finance the development of such land with modern machinery, for the prospects of large profits from supplying the world's market with foodstuffs are too good to be ignored. The very success of American farmers in the past is a potential danger to them, for the farmers in other countries are naturally desirous of making enough money to afford the conveniences and even luxuries which American farmers have acquired.

And when they realize that the only real advantage the American farmer possesses is his more efficient equipment, and this equipment can readily be purchased, it is only a to be expected that they will avail themselves of it so far as practicable. Especially is this true when the government officials in foreign countries explain to their farmers the advantages they possess over American farmers in the matter of land, labor, transportation and taxes, and that by using the equipment of the American farmer the prosperity of the American farmer is also theirs. And this is just what has occured; it was too much to expect the old conditions to continue indefinitely.

So, while the phrase, "The American farmer leads the world in production per man," has become so common that most people seem to take it for granted that it is not only true but will always be true, there is abundance evidence available to any one who will look for it, that the statement is open to question, and if it is not already untrue it is likely to become so in the near future.

Many officials of foreign countries have made inspection tours of our agricultural sections during the past few years to learn the reasons for our low cost of production. There was only one reason for it, and it was so obvious that not one of them failed to find it. They also returned home and recommended to their farmers that they adopt the same labor-saving equipment. In many countries they could not hope for any great success in adopting such equipment, because of the small farms, the force of custom, and other obstacles. But in other countries there were fewer and less serious obstacles, and considerable success was atained, as will be shown presently.

And how about the American farmers in the meantime? Were they improving their equipment also, like our manufacturers, so that they were still in the lead? Were they encouraging the development of improved machines? Were their advisors pointing out to them the desirability of improving their equipment, or the menace in not doing so? quite the contrary. Instead of being improved, the American farmer's equipment was, on the whole, deteriorating. Not only has he bought less new equipment, but much of what he has bought has been in small and uneconomical sizes. And instead of the foreign competitors finding themselves still inferior to the American farmer in efficiency, they actually became, in thousands of cases, superior to him.

It is a difficult matter to estimate closely to what extent farmers have allowed their equipment to deteriorate and avoided replacement of machines which had reached the end of their profitable life. C. O. Reed, of the Ohio University, analyzed the production figures on farm machinery as gathered by the government, and estimated there was an accumulated shortage of farm machine units during the years 1919 to 1923, inclusive, of nearly six million. Estimates of this kind, however, are unsatisfactory. Only a wide and comprehensive survey would give us the actual facts as to the efficiency with which American farms are today equipped. The most casual observation, however, will convince any one that the vast majority of American farmers are using equipment in smaller sizes than are most economical.

An investigation made last summer showed that farmers in one section of Iowa were using grain binders in the 1924 harvest which averaged about seventeen years of age, with only three less than ten years old and with several which had worked through thirty or more seasons.

There is no reason to believe that the situation with regard to grain binders is very different from that of other machines. If this is true, thousands of American farmers are attempting to earn a livihood for themselves and families by producing crops with old and labor-wasting machines, the average present age of which is already higher than the average total life is generally supposed to be.

And now what about improvements in equipment in competitive agricultural countries for the last few years? To any one who will look for it, there is plenty of evidence of the rapid gains several of them have been making on

American farmers. Space will permit presenting only a little of it.

First, the value of agricultural implements exported from this country for the past few years is significant, especially since we are now exporting none to Russia, which was formerly a large buyer. The government figures for the year ending June 30, 1924, show a total export of $60,904,888 worth of farm machines, as compared with $37,734,024 for the year ending June 30, 1923, which was a good year.

Not only are the latest figures the highest on record but the business is increasing. One of the large implement manufacturers in their annual report state:

"It is interesting to note that over one-half the total business for 1923 represents sales in foreign countries and products other than farm equipment. The foreign trade prospect for 1924 indicates a further gain."

Does that mean anything to American agriculture?

That is general; let's just glance at a few individual countries.

The last year or two, because of unfavorable weather and numerous other handicaps, agriculture has not been particularly prosperous in Canada, though strong efforts are being made to make it so. Yet our own Department of Agriculture recently stated:

> "Exports from Canada for the year ending June 30, 1924, are estimated at 349,000,000 bushels which sets a new record for the net exportation of wheat from any country in any one year. Thus the United States, which for fifty years, except for a few years of short crops, led the world in wheat exports, dropped to secand place in 1922-23, and to third place in 1923-24, with net exports of only 126,000,000 bushels as against 165,000,000 bushels from Argentina."

One agricultural authority recently said:

> "Bank on this; Canada is not going to stop rolling over the sod of her untilled acres merely because somebody in the states or elsewhere wants production curtailed. Business is not carried on from that standpoint these days north of the line."

Incidently the absurdity of attempting to improve our agricultural situation by limiting our production when other countries are doing everything they can to increase theirs is obvious. Yet there are many so-called "agricultural leaders" who have been preaching "limited production." Limiting the cost of production would seem to be a more rational program.

America Needs Fewer Farm Workers and More Production per Man

What American agriculture needs more than anything else is an increase in our boasted production per man, a greater total production, and fewer workers to divide the income from our farm products. Too many farmers, and people who claim to speak in the interest of farmers, preach about the need of higher prices, and what a blessing they would be to our farmers and the nation as a whole. They overlook the fact that higher prices for farm products are certain to stimulate our foreign agricultural competition, and that they will eventually prove as much of a curse as a blessing. On the other hand, a lowered cost of production on the part of our farmers would give the same immediate results as higher prices, with the added advantage of discouraging foreign competition instead of encouraging it. Lowering our production costs is more desirable from every angle.

As against the proposed limited production for the United States, we are told by the Dominion Bureau of Statistics that Canada this year had over 56,000,000 acres of crops as compared with a little over 53,000,000 last year, and that occurred under unfavorable conditions. It doesn't require a prophet to predict what will happen in 1925 if prices of grains remain high.

The possibilities of Western Canada are too well known to warrant detailing them. The progress which has been made there is likewise familiar. In spite of numerous handicaps, Western Canadian farmers have become, as a class, exceptionally efficient, and are producing small grains and other crops much cheaper than most American farmers, and part of this lower cost is due to their greater labor efficiency.

And at least one of the government experiment stations is making practical field tests to determine the labor efficiency of different machines as well as their general efficiency of performance.

Argentina is another country from which American farmers are already meeting considerable competition and from which they are certain to meet a great deal more in the near future. A country which can make us take third place as a wheat exporter, even in an off year, is certainly not to be dispised.

Conditions there have been well compared with those which existed in this country just after the Civil War. There are enormous areas of fertile virgin land to be brought under cultivation, a favorable climate, an abundance of low-priced labor, a good export market, and new and exceptionally efficient machinery available which is not bein gused elsewhere to any great extent—a wonderful opportunity, and one which if it is developed as is now planned will in a very short time have a serious effect upon the prosperity of our farmers.

A year or two ago, when the condition of our wheat growers was receiving so much consideration from all quarters, and higher prices were declared to be imperatively needed, a well-informed Argentinian declared that Argentine farmers would be only too glad to raise all the wheat the market demanded for the prices which Amercian farmers declared ruinous to them.

How could they do it? Good soil, good climate, low-priced land, low-priced labor, and last, but by no means least, efficient equipment.

American Farmers are Slow to Adopt Larger and Most Improved Farm Machines

Though labor-saving machinery is not so essential when labor is cheap, the Argentine farmer is nevertheless using it—the latest and most improved kinds and in large sizes.

The combined harvester-thresher is an American invention and is the cheapest method yet devised for harvesting wheat. It has been available to wheat growers for years. Yet it is used to only a limited extent in this country, even in those sections where conditions are favorable for its use. About half the Argentine wheat crop is already being harvested with the harvester-thresher and its use is spreading rapidly.

The foreign representative of an American implement concern stated that Kansas farmers alone should buy more of these machines than are being sold in the Argentine, yet the Argentine sales are actually several times as great as the total sales for the United States. Surely that is significant.

The sizes of grain drills Argentine farmers are buying is also worth noting. Less than 20 per cent have less than twenty markers. In this country, even in the wheat sections, the percentage of drills with twenty or more markers is far less than in Argentina.

Argentine farmers buy twice as many 8-foot binders as they buy of the 7-foot size—and nothing less than a 7-foot binder is salable there. Let the American wheat growers check that against their binder equipment.

In this country there are a great many more two-plow tractors sold than there are of the three-plow and larger sizes, and only a small percentage of our farmers have adopted mechanical power for their field work. In the Argentine the value of the tractor is more generally recognized, and the three-plow and larger sizes are much more popular. Furthermore, in the case of tractors which can be furnished with a power take-off, this attachment is bought in a greater percentage of cases than in this country.

Corn is also becoming an important crop in the Argentine, and practically all that is grown is for export. On this crop, also, they have cut down the labor requirements considerably below the average for our corn belt farmers.

In this country the two-row cultivator, although it has been on the market for years, is used comparatively little. The Argentine corn grower commonly cultivates three rows at a time, and seldom less than two.

Men who have spent considerable time in the Argentine

studying farming conditions report that although the standard of living is far below that of American farmers, the efficiency of the workers is, on the whole, greater than in this country. This, together with the natural advantages they possess, assures the Argentine farmers of satisfactory profits at prices below what American farmers would consider ruinous.

It is only natural that Argentine officials are doing all in their power to encourage the development of their agricultural resources in the most efficient manner—their opportunity is too good to be missed.

Just a few years ago the Argentine minister to the United States spent considerable time, while in this, country studying our farming equipment, both its construction and its performance in the field.

Shortly after he returned to Argentina he became secretary of agriculture. In this position he used his best influence to encourage the adoption of the most efficient American farm equipment, and the present large sales in that country are due in no small part to the recommendations of this man and other government officials, doing what they considered their patriotic duty.

In Australia we have another country from which we may expect a great deal more competition than we have had in the past. In this connection, Bulletin 166, issued by our Bureau of Foreign and Domestic Commerce, on "Agricultural Implements and Machinery in Australia and New Zealand" may be of interest.

Australia has already reached sufficient proportions as a wheat producer to affect our prices very materially. In passing, it may be well to illustrate how even the limited foreign competition we have met has affected the incomes of American farmers. We have a splendid example in 1924 wheat prices.

The Big Need is to Encourage the More Extensive Use of Labor-Saving Machines

Early in the year, with normal prospects for Australia and Argentina, our wheat prices were low, for world buyers expected to be able to buy wheat cheaply from them. Then they encountered unfavorable growing conditions and in the American Farm Bureau Weekly News Letter of November 13, 1924, we read the following:

"But with the hesitation of the political campaign over, the influence of the extremely bullish world situation, which is generally conceded, fully exerted itself and previous opinion on this subject received further impetus from numerous reports of a deterioration of crop prospects in the Argentine which imply a decrease in the amount of wheat available for export.

"The news concerning crop conditions in Australia is not encouraging and continued rainy weather is affecting the quality or the growing crop. Thus the past week has brought about a remarkable change in the situation, particularly so far as demand for American grain is concerned."

Many of our farmers who sold wheat early in the season received less money for their crop because of what Argentine and Australian farmers were doing. The latter were unlucky this year—they had bad weather. Suppose they hadn't. Suppose they have good weather next year. They don't always have bad weather. Suppose we get bad weather next year and have a small crop while they have a large one.

Some people believe that our tariff of 42 cents per bushel on wheat will take care of such competition. Other people who have studied the matter quite thoroughly believe it won't. At any rate, we have had the tariff for some time and the price has gone up and down much the same as before.

But to return to Australia. Her wheat crop is produced today more efficiently than ours. Practically one hundred per cent of it is harvested with the combined harvester-thresher, or the stripper which is about as economical. There, too, tractors are being adopted more rapidly, proportionately, than here.

And the government is not only urging Australian farmers to equip themselves efficiently, but has adopted a policy of protection and export bonuses for efficient industries only which will more or less compel their farmers to produce efficiently, if it is carried out as announced.

Perhaps an export bonus for efficient producers only is what our farmers really need. It would at least be interesting to learn what percentage of them could qualify for a bonus under such an arrangement.

Most corn-belt farmers would probably be surprised to learn that one of the largest, if not the largest, corn growers in the world is located in South Africa, where he is known as the "Mealie King." Last year he produced about 300,000 bushels of corn.

Serious competition from South Africa will probably not be encountered nearly as soon as from the three countries already named, but it is by no means a remote possibility. The same is true of Russia and India. This particular instance is mentioned merely to show how rapidly changes may be expected, and also to prove that the competitor who is behind can often take a short cut. The "Mealie King" recently made a tour to study farming in other countries and upon his return announced that he intended to adopt tractors in place of his oxen, for oxen were too slow and required too great an area of grazing land which could be profitably put in corn. He also stated that farming in South Africa could be made the equal of anything he saw on his trip and that that country offered a better opportunity for success because of the abundance of cheap, fertile land available there.

As a farmer using oxen for power, the "Mealie King" would be looked down upon by almost every American farmer. But as a tractor farmer, he is in a position to look down on most American farmers who are still using horses, which are only a little more efficient than oxen.

Being looked down upon as an inferior is something no real American enjoys. It is especially humiliating to have our competitors excel us with equipment we have ourselves developed and manufacured. Yet that is exactly the situation we are today confronted with—and it is a condition we are facing, not a theory.

Studying the causes which have brought it about are now of little consequence except as the knowledge of them may help in remedying the situation.

When we read repeatedly in Government publications that labor and power represent about forty per cent each of the operating costs in producing crops, and since we know that using more and better machinery is the only way of making any material reductions in these items, it seems inconceivable that so little effort has been made by the U. S. Department of Agriculture and our agricultural colleges to encourage the greater use of labor-saving machinery on our farms.

Yet it is a fact that very little work of this kind has been done.

STUDIES OF SOIL MOISTURE IN RELATION TO DRAFT

This picture shows a set-up for the study of the relation of moisture to draft in plowing. In this case an effort has been made to keep the power unit off the field. The plow is drawn by a cable fastened to a drum operated by a tractor. The recording apparatus is an Iowa dynamometer. This work is preliminary to further studies to be undertaken at the Kansas State Agricultural College on the general subject of determining the draft of plows

Even when individual farmers, through the effective utilization of equipment, have reduced their production costs so much that they made very satisfactory profits at prices which did not repay the cost of production to other farmers, practically no recognition was taken of it.

A slight increase in the yield of some crop by soil inoculation, seed treatment, the use of lime, or in some other way, would result in an investigation and publicity. But a saving of power and labor of several times the value of the increased yield, through the use of a lister instead of a plow, a two-row cultivator instead of a one-row, or mechanical power instead of animal power, receives no attention whatever.

Had such cases, of which there are thousands, been studied by competent engineers, and the results published for the benefit of other farmers, it seems likely our farm equipment would today be a great deal more efficient than it actually is.

It is not going too far to state that it should have been the province of someone connected with our Department of Agriculture and our colleges to help work out some of the problems individual farmers have solved, often after considerable unnecessary expense.

But in the matter of actual utilization of farm machinery to keep costs at a minimum, help or advice from the institutions mentioned has not only been extremely limited but sometimes has been of a negative nature.

A good example of such negative advice is found in the case of a young man who enrolled at one of our large agricultural colleges in order to fit himself to manage his father's 200-acre farm.

After he had left the college and had been managing the farm for some time, he had an interview with the president of the college. He was asked how he was getting along and he reported that the farm was not showing the profit he would like and that he had been studying the matter a great deal to learn where the trouble was and had reached the conclusion that it lay in his low labor efficiency and the expense of keeping his work horses.

He stated that he had been trying to figure out a way of doing without horses altogether for his farm work, as his records showed each of his nine work animals cost $175 annually for maintenance, and he asked the president's opinion as to the feasibility of the plan?

The president condemned it in the strongest possible terms, stating it was entirely useless to try to operate a corn-belt farm without horses—that it had never been done and probably never would be done.

Fortunately, the young man had the courage of his convictions; his study of the problem had convinced him there was at least a good chance of success. He made the trial and succeeded. This year he planted, cared for, harvested, stored and marketed his crops entirely with mechanical power, besides doing considerable profitable custom work using a three-plow tractor, two general-purpose tractors and a motor truck.

This picture shows a series of brush dams for checking soil erosion in South Dakota. Photo by courtesy of agricultural engineering department, South Dakota State College

Even after deducting the cost of the new equipment he purchased in making the change from animal to mechanical power, the farm has paid a much greater net profit than he had ever been able to make with horses and his operating costs on all the crops were reduced so materially that the figures, and the methods by which they were obtained, should be of value to nearly every corn-belt farmer. Exceptionally good crop yields were obtained in every instance. The quality of the work done was of the best, as was also the quality of the crops. From every standpoint, any unbiased person would say the project was entirely successful.

American Agriculture Needs the Service of the Agricultural Engineers Greatly

It is impossible to give the details of this enterprise, though they are worthy of being embodied in a special report or paper to be presented before this society—they should certainly be made available to other farmers.

And yet they are undoubtedly susceptible of great improvement. This year's experience shows that certain changes in the equipment were desirable and will be made as soon as practicable; it was found that more land could be farmed with the present equipment and eighty additional acres have been rented for next year. But the results already achieved, as shown by the bank account, prove that this man was correct in his belief that increasing his labor efficiency and cutting down his power costs would add considerably to his income.

After he had proved that he could do his farm work entirely with mechanical power and save in both labor and power costs, the young man wrote to the president of the college and told him what he had done and sent pictures showing how he had solved some of the problems which had arisen, such as raking hay, getting it into the mow, etc.

The president wrote back:

"This is certainly an innovation. I will not be surprised if you resume the use of some horses, and I wish you would let me know if this proves to be necessary."

Which is almost equivalent to saying: "It can't be done, even if you have done it."

Now why should the president of an agricultural college take this sort of attitude in such an instance? Surely it indicates that he was not informed as to the present state of development of mechanical power plants for farm work, the real need of reducing labor and power costs, the possibilities of doing so, and the service his institution should be prepared to render to farmers in such cases as this.

Why should he not have said to this young man: "You are on the right track in trying to reduce your two largest items of operating costs, and I hope you will be successful in doing so; I suggest that you get in touch with the agricultural engineering department and see if they can help you work out the problem—that is right in their line."

But his attitude is fairly typical of the attitude toward engineering problems of many of the high officials of our colleges and of the Department of Agriculture. The agricutural engineering profession is by no means as well known and as prominent as it should be, in spite of what it has accomplished. We might ask why no representative of the profession was appointed on the recently appointed agricultural commission, as well as on other bodies which have studied agricultural problems in the past, for we know that the agricultural engineer could come nearer diagnosing the trouble and prescribing the best remedy than representatives of any other branch of agricultural science.

Is not this lack of recognition from many quarters due to the fact that the profession has failed to take advantage of its opportunities? It has been, and still is, within its power to render a greater service to American agriculture than can be rendered by any other scientific body. And there never was a time when American agriculture needs this service more than it needs it today. If it renders the

WHO IS AN "AGRICULTURAL ENGINEER?"

If the primary function of an engineer is the application of engineering to agriculture, he is an "agricultural engineer." He may be devoting his efforts to the design and development of mechanical and structural farm equipment in a manufacturing organization; or he may be designing and developing special materials, parts, accessories, etc., for farm equipment. He may be engaged in teaching, research or extension work in agricultural engineering in a land-grant college or experiment station, or in the federal department of agriculture. He may be connected, in an engineering capacity, with any of the several phases of land reclamation and development. He may be offering his services to the public as a "consulting agricultural engineer." In other words, if his main efforts are in the direction of putting agriculture on a better economic and engineering basis by increasing efficiency, lowering costs, and raising the standard of living on the farm, he is an "agricultural engineer." This defines the conception of the American Society of Agricultural Engineers of who and what an "agricultural engineer" is.

service it is possible for it to render, its proper recognition cannot be withheld.

The menace to the prosperity of American farmers as briefly sketched here is by no means overdrawn, but quite the reverse; numerous other facts could be cited to prove this. It lies within the power of the agricultural engineers to help prevent the serious consequences which are threatened.

No attempt will be made here to recommend any course of action for this Society, but it is hoped that in the discussion some acceptable plan may be suggested for this Society to follow in order to fulfill its duty to our agricultural industry by teaching American farmers how they can successfully meet this very real menace of foreign competition.

Discussion by E. W. Lehmann

Professor of Farm Mechanics, University of Illinois

IT would seem to be appropriate for me at the outset to defend the colleges and experiment stations; however I do not believe that is necssary, for their work will stand on its own merits.

We must not overlook the fact that the interests of the colleges and the interests of the manufacturers of farm implements are one and the same; as far as the farmer is concerned, both are or should be interested in the farmer's success. When I hear of the success of college men in doing the job of farming, I want to commend the colleges for their good work. After all the greatest need of the American farmer is education. The farmer's business is no different than any other business in that to succeed he must know his business, and the correct principles of economics must be applied to it.

I feel that we can all endorse what Mr. Yerkes has said in regard to the part machinery has played in the past in increasing production per man in American agriculture. There is no question but that the ingenuity of such men as Deere, McCormick, Hussey, Pitt brothers and many others who might be mentioned in developing machines of agricultural production, have contributed beyond measure to the progress of the art of farming, and in solving the problem of an adequate food supply. I think instead of magnifying the importance of foreign agricultural competition, the extent of which is apparently in the hands of those who supply the implements to foreign competitors; as engineers, we might well give our attention to the menace of the ignorant farmer, to the eradication of the corn borer and the cotton boll weevil, to the need of greater efficiency in our present machinery, to the need of new machines for handling new crops, the solution of which should require the combined efforts of our Committee on Power Farming, and in fact the entire membership of the Society.

As engineers, interested in the success of the farmer and in comparing his lot with the manufacturer, we must not overlook the fact that in manufacturing production the efficiency engineer does more than advocate the purchase of more and more machinery. He finds that by improving the illumination the efficiency of the piece worker is increased 200 per cent, by proper routing much lost motion can be eliminated. The question of organization and management is most important. The raw products are given more and more attention, and the labor must be skilled. The same principles will apply in farm production.

With an abundance of good cheap land the chief need is always machines of production with adequate labor to operate them. However, we cannot get around the fact that the soil is at present the biggest limiting factor in American agricultural production. The same is more or less true of world production. Only last week Dr. C. F. Marbut, chief of the federal soil survey of the U. S. Department of Agriculture, gave a series of lectures at the University of Illinois, and in discussing the soil and agriculture of Argentina, where he spent some months of study, he stated, "In my opinion we need not expect any very rapid increase in corn or wheat production in Argentina in the future. Both will increase but the period of very rapid increase, in my opinion, has passed. There are large areas of land in Argentina not yet cultivated in either corn or wheat, but these lands are not as good as the lands that have heretofore been brought into cultivation and they will be brought into cultivation in the future at a much slower rate, in my opinion, than have the other lands, now being cultivated, been brought in."

In regard to conditions in other countries Dr. Marbut states, "It seems that we shall have more competition from Canada and from rehabilitated Russia, in case rehabilitation comes soon, than from Argentina or probably from Australia. I do not know what the conditions are in Australia, but the fact that her wheat production has fluctuated in the past indicates that she is producing it on a land of uncertain productiveness. In the growth of wheat there is a great menace in foreign competition, especially in Russia and Canada. In corn this is not true. In the long run no other country can compete with us in corn production."

There are three equally important factors in efficient and economical production: land, labor and capital. Every manufacturer recognizes that there must be a proper balance between these factors for economic and efficient production. Where there is an abundance of good land the tendency is toward the bonanza type of farming, rightfully called agricultural exploitation. The recent rapid agricultural development in Argentina has been due to this type of farming; the primary need there was machinery. The same was true on our Middle West farms fifty years ago, but with our best land utilized we cannot put too much emphasis now on the soil; the life of our nation depends on it. Much of our soil is already becoming depleted of its fertility. For efficient and economic production our land must be well drained, it must be protected from erosion, and it must be used in accordance with the best farming practice to maintain a high state of fertility.

With the present labor situation, the high wages of the cities competing with the farm, labor must not be wasted in using poor and inadequate equipment. Farming operations must be more carefully studied so that the distribution of labor will tend toward more efficient and economic production. Reorganization and proper management will do much toward improving agricultural conditions.

The chief investment of capital on the farm is for buildings and equipment including machinery. The farmer's equipment must be adequate for the needs of the farm and for efficient and economic production, but it should not go beyond that. It is equally important for the farmer not to have too much capital invested as it is too have too little. The man with the poor land and cheap labor cannot afford to purchase a lot of machinery. The farmer who farms the poor land of Illinois or Texas cannot be expected to use the same equipment as the farmer who farms the black land of these states. It is folly to expect to substitute gang-plows for sulky plows, or sulky plows for walking plows, or eight-foot mowers for six in every case; it can't be done. We must also keep in mind that there are all kinds of farmers. There is the educated and the illiterate, the practical and the impractical, the wise and the foolish, and all groups in between. With such a group of producers we must for our own good, not try to fool ourselves into believing that more machinery and equipment is necessarily the panacea for all their ills.

I believe we will all agree, however, that there are many farms that have become underequipped during the last four or five years due to the reduction in the buying power of the farmer during this period. That the farmer will purchase machinery, however, when he can afford it, is evidenced by the great increase in value of machinery on farms during the ten year period, 1910 to 1920. In Illinois according to census reports the value of farm machinery increased in round numbers from 73 to 222 million dollars, over 200 per cent. A small part of this increase was due to the purchase of tractors and a rather large part to increased costs of machines. However, there is little doubt but there was an increase in the number of machines.

It is also interesting to note that in comparing the years was a decrease of 1.7 per cent of all farm land and a decrease of 2.7 per cent in improved farm land in the state. It is also interesting to note that incomparing the years 1909 to 1919, although we find an increase in the acreage devoted to cereals, we find a decrease in cereals of 15 per cent; other grains, seeds, etc., a dcrease of 45 per cent—in fact a decrease in practically all the staple crops. With the lower production of 1919 and the abnormal conditions and greater demand the value of the products was increased over 100 per cent more than in 1909. The increased buying power of the farmer, the labor situation, and his desire to make things easier on the farm prompted the purchase of a lot of labor-saving machines.

A modern, engineered dairy barn on the farm of E. M. McCollough, Fayette County, Kentucky. This barn is 34 by 72 feet, with braced rafter gambrel roof. It provides for 28 cow stalls and office and feed room at one end. It is equipped with the King system of ventilation, metal equipment, concrete floors and mangers, and electric lights. There is a 12-by-40-foot silo with a 12-by-13-foot water tank on top. Agricultural engineers at the University of Kentucky are recommending this type of barn to the dairy farmers of the state

During the war with the high cost of labor and the urgent demand for food, the farmer was justified in heavy expenditures for machinery. With lower labor costs and less demand for his products at present the farmer is rightfully practicing greater economy of production and more carefully scrutinizing his expenditures. He must be a better mechanic as well as a better manager, and his machines should last longer. During the last few years the farmer, not unlike the manufacturer, has not had the demand for his products and therefore he has done the only thing he could do, that is, economize until it hurt. While he has been economizing, he has been doing just what the level-headed manufacturer would do, he has or should have been thinking of all the factors affecting the costs of farm production, and he has been repairing his machines. The data from cost accounting records indicate that low machinery costs go with low production costs.

Closer Cooperation Between Farmers and Farm Equipment Manufacturers Needed

One of the great needs of the farmer at the present time is a closer cooperation with the implement people. The implement dealer will do well to study the farmer's production problems; the wide-awake dealer who can analyze the farmer's needs and will sell him the only thing that he is sure will give a return on the investment, will contribute a real service to agriculture. It pays neither the farmer nor the inplement industry when the wrong machine is sold; business cannot be built on mistakes. The farmer's capital invested must pay dividends and this is the only basis on which he can afford more equipment.

The only basis on which a state college will make definite recommendation for greater investment in capital is on the basis of fact. We need more accurate cost records. I think the implement dealers might do a great service in assisting the farmers in keeping accurate cost records so that they, as well as the farmers, would know what the limiting factors are in agricultural production. There are factors affecting production with which we should all be more familiar. The time factor in farming has not been given the emphasis it justifies. Illinois Bulletin No. 214 "Spring Wheat in Illinois," contains some interesting information in this connection. To take advantage of the influence of climate on soil the farmer must have adequate power available.

As a group of engineers we must be unbiased in our recommendations. In our effort to sell our wares we must not overlook the basic factors in agricultural production. If the fertility of our soils were inexhaustible we could well give practically all our attention to the machines of production. We know that no farmer can be a success who is not a good husbandman.

For the greatest measure of success the farmer needs to put into practice what has been found best in rotation of crops, seed selection, soil improvement, in the selection of animals, etc. From our experiment station we can secure data that will show how production can be increased and fertility maintained by proper management. I think that our state colleges have been unduly criticized for emphasizing these factors and apparently paying a disproportionate amount of attention to the question of machinery. This is no doubt due in part to the fact that there are already thousands of agencies selling the idea of better equipment to the farmer. As an organization of engineers, I repeat that we must take an unbiased view.

For the greatest economy in production we must have a proper balance of all factors in production. If we do not have the proper balance, we will have the same situation in farming that is found in some of the industries at the present time—on the rocks because of overcapitalization. The farmer may overcapitalize in the same way, unless his whole system of farming is carefully organized. The farmer who does custom work, or the farmer who gets more land after buying additional equipment has reorganized his method of farming. Only relatively few of our 6,000,000 farmers can do custom work and make their added capital

pay, and we all realize it will take considerable readjustment to change the size of our farms.

While I do not have a plan such as Mr. Yerkes hoped might be suggested, I would like to propose a few questions to which we might all give serious thought, the answers of which should be helpful in making an analysis of this problem—the menace of foreign agricultural competition.

First, what is agricultural efficiency? It is not overproduction. It is not increased production per man at the expense of soil and poor economy. It is not a violation of the economic law of proportional factors.

Second, what are the actual items of expense and the amount of each item entering into the total cost of production of our chief crops, for different parts of the United States and for foreign competing countries. Graphic charts showing this could be prepared from data available from many of our state agricultural colleges.

Third, what are the chief factors that govern agricultural prosperity? This might also be shown graphically. Some of the factors would be the soil, seed, climate, disease and pest control, equipment and machinery, labor and power, management, supply and demand, marketing, cooperation, etc. I wish to recommend to the Committee on Power Farming that they give thought to the above three questions and others that might be proposed. Above all we should have a constructive program.

A Letter from Mr. Yerkes

Dear Mr. Olney:

OWING to the lateness of the hour when Prof. Lehmann read his discussion of my paper at the December 3rd meeting of the Farm Power and Machinery Division of the Society, there was no opportunity for me to say anything regarding some of the points he made. His discussion contained a number of statements with which I would take issue, and if my paper and his discussion are to appear in the records, I would like very much to add a little further discussion to just a few of these points.

First, I would like to point out that the extent of foreign agricultural competition is not in the hands of American manufacturers who are selling equipment to foreign farmers, for if American manufacturers did not supply this equipment, English and German manufacturers would do so and be very glad to have the opportunity. So long as prices for grains are high, there will be a strong incentive to develop the large areas of virgin land available in different parts of the world and machines for this purpose will be demanded.

Instead of agricultural engineers giving their attention to the eradication of the corn borer and the boll weevil, as Prof. Lehmann suggests, I think it much better that they first solve the many engineering problems before them and leave the entomological problems to the entomologists, who vigorously attacked these problems at their inception and apparently are handling them in a very competent manner.

The same is true regarding our soil problems—the soil chemist and bacteriologists seem perfectly competent to handle them.

While everyone must admit the value of entomological and soil research, I do not believe that it offers the possibilities of as great benefits to agriculture as agricultural engineering research of the proper kind. However, if the engineers themselves admit that soil and other factors are of greater importance than engineering, it is only to be expected that appropriations for such work will continue to exceed those for engineering.

Dr. Marbut's opinion regarding the future development of Argentine land is at variance with the opinions of other observers who have had better opportunities for study of the situation, and the recent large sales of machinery in Argentina certainly indicate that greater activity in agriculture is to occur.

The statement that cost accounting records indicate that low machinery costs go with low production costs is open to question, for many such records indicate the exact opposite, and papers delivered before the Society by different authorities have shown that the better equipped farms produced in greatest quantities and at lowest cost.

The three questions which Prof. Lehmann proposed at the end of his discussion lie almost entirely within the province of farm economics, and quite complete answers are available in the literature issued by the various farm economists.

I would like to point out we have never had such a thing as "over-production." What is sometimes called by this name is only the "competition" to which I referred. For one hundred and fifty years our farm surplus was considered a great national asset and only recently, when other countries have really begun to compete in the world market, has it been considered a menace.

Instead of increased labor effciency being a violation of the economic law of proportional factors, the present situation on American farms is a direct violation of this law, and it was the sole purpose of my paper to prove this point. There has been too much emphasis placed upon the less important factors and not enough upon the most important factor of all, the efficient utilization of man labor and power.

ARNOLD P. YERKES

Rural Electrification Needed

THE September 1924 issue of the "Experiment Station Record," published by the Office of Experiment Stations of the U. S. Department of Agriculture, contains an eight page editorial on the present and prospective status of electricity, based largely on the paper, entitled "Some Research Features on the Application of Electricity to Agriculture," by R. W. Trullinger, presented at the 1924 annual meeting of the American Society of Agricultural Engineers. The purpose of the editorial primarily is to point out to agricultural experiment stations the opportunity and necessity for constructive research necessary for the development of rural electrification. The editorial is concluded with the three following significant paragraphs:

"The conclusion seems inevitable that not enough of a fundamental nature is now known regarding the exact requirements of the more important processes of specific types of farming to justify the immediate and arbitrary electrification of large rural areas. While a considerable amount of both fundamental research and more elementary investigation has been undertaken, much lack of knowledge and even disagreement on important specific points is evident, indicating the necessity for more systematic experimentation in many cases to establish the facts involved. In other cases the work has never advanced much beyond the suggestive stage, although the progress findings have been quite promising. In still other instances, such as tillage, the basic principles of the practice itself have never been established, thus indicating the necessity first for research on the process and then for the development of the machinery required to perform the process before electricity can be applied effectively and economically as the source of required power. Apparently only in a comparatively few cases are the agricultural facts so well established that the work remaining amounts merely to an exercise of applied agricultural engineering.

Thus it seems evident that the rational application of electricity to agriculture will require, first, a large amount of fundamental agricultural research to provide a foundation for the movement, and, second, a certain but gradually increasing amount of engineering and experimentation to determine power requirements and exact electrical applications.

"The opportunity open to the stations for constructive contributions to the problem seems apparent. There is the special incentive that a disposition already exists on the part of both prospective producers and consumers of electrical energy on the farm to utilize as rapidly and completely as possible whatever findings may be made available."

It is obvious from this conclusion that to insure the development of rural electrification along sound economic and engineering lines an extensive program of research is essential. This presents both an obligation and an exceptional opportunity to agricultural engineers.

Research in Agricultural Engineering

Research activities in the agricultural-engineering field are presented under this heading by the A. S. A. E. Research Committee. Members of the Society are invited to discuss material presented, to offer suggestions for timely topics, and to prepare special articles on any phase of agricultural engineering research

Major Problems in a Study of the Irrigation of Rice by Pumping

By Deane G. Carter

Professor of Agricultural Engineering, University of Arkansas

THE importance of the rice crop in the southern prairie states has reached a stage at which the economic necessity for research to provide more fundamental information on the growing of rice, particularly on that phase relating to irrigation has become quite evident. Much of the information forming the present basis for rice growing in those states, and especially for the irrigation phase thereof, has resulted from slow and empirical experimental work conducted mainly by the farmers themselves. Such work is frequently not only of doubtful value but its very nature and the surrounding circumstances have permitted changes and improvements to be made only very slowly. Consequently many rice growers are still using methods which were formulated years ago and which were in many instances perhaps not very sound fundamentally to begin with.

In the face of this lack of fundamental knowledge of both processes and unit costs, many engineers may be surprised to learn that the United States is a rice exporting nation. The yearbook of the U. S. Department of Agriculture for 1906 credited Arkansas with only 4,000 acres of rice, while in 1922 the area harvested amounted to 154,000 acres. The 1910 year book of the U. S. D. A. listed 100 acres of rice for California. This was increased to 140,000 acres in 1922. The somewhat more rapid increase in the rice acreage of California than in that of Arkansas is a significant feature of the problem in hand, when it is considered that irrigation water was obtained mainly from reservoirs and canals in California and by pumping from wells in Arkansas. Louisiana has always been the leading rice producing state. However, in addition to Arkansas and California, the states of Texas, South Carolina, Georgia, Mississippi, and Florida also produce rice in commercial quantities. Missouri also has grown rice in an experimental way for the past two seasons. In 1923 rice was exceeded only by cotton in the cash return to Arkansas farmers, although the rice area of the state is only about 50 by 150 miles in extent.

Since irrigation is required to permit the growing and proper maturing of rice in these states, it is self-evident that the amount of rainfall received during the growing season is insufficient in amount for this purpose and is probably also improperly distributed. Futhermore, the situation is very much complicated when it is realized that considerably more than 90 per cent of the water required in the irrigation of rice in the southern rice growing sections, particularly in Arkansas, Louisiana, and Texas, is obtained from wells or basins and must therefore be pumped. The California rice area is apparently the only one in the United States which is irrigated mainly from reservoirs and canals.

There is a large amount of information available on the general subject of irrigation and a small amount on methods and cost of pumping for irrigation, but there is very little or practically no specific fundamental information on the irrigation of rice, especially by pumping from wells, under the conditions prevailing in the southern prairie sections. When it is considered that, according to the census of 1910 and 1920, the investment per acre for the irrigation of rice during that 10-year period increased 155 per cent in Arkansas alone, it would seem that a greater knowledge of the fundamentals of rice irrigation which influence its cost is of great importance. In view of this lack of knowledge, the economic importance of the rice crop, and the apparently increasing cost of rice production, it seems quite advisable to consider some of the major problems involved to provide a basis for the formulation of a somewhat definite program of research in the subject, which would have for its object the elucidation of all the factors of rice irrigation and placing them as far as possible upon a definite and controllable cost basis.

It seems of obvious fundamental importance to realize at the beginning that a thorough study of the irrigation of rice by pumping is a broadly cooperative undertaking. In fact a study of the situation indicates that it involves meteorological, field crops, soils, and economics factors as well as agricultural engineering factors, thus showing at the outset the importance of cooperation by the agricultural engineer with specialists in these subjects. In addition, consultation with agricultural engineers specializing in irrigation or drainage engineering may be necessary, and in case electrical pumping is investigated it may be necessary to cooperate with electrical engineers.

An investigation and analysis of the meteorological factor involved in rice growing would seem to be the logical first step in planning a study of rice irrigation. Such a study should be planned to establish maximum and minimum temperatures of the locality, minimum temperatures permitting the growth and maturity of rice in the locality, the range of temperature throughout the rice growing season, the average, maximum, and minimum precipitation of the locality, and the amount and distribution of the precipitation during the rice growing season. This study of meteorological factors becomes increasingly important where the rice area is extended farther north, as indicated by the experiments in Missouri. In this connection Italian experiments showed that the minimum temperature limits are of great importance in the early stages of the growth of rice, the minimum varying from 46 to 50 degrees Fahrenheit. The maximum rate of growth was found to be associated with a high minimum temperature, acompanied by warm, short nights. Low temperatures occurring during the important and tender stages of heading inflorescence, and formation of grain were found to cause considerable damage. The meteorological studies are even more important where evaporation is excessive, rainfall excessive at critical periods, or soil and subsoil conditions are variable and possibly unfavorable from the standpoint of the absorption and retention of moisture.

The next consideration would seem to be to determine the total amount of water required by rice for growth and maturity, under the prevailing meteorological and soils conditions of the locality, and the facts governing its optimum application throughout the growing season. This not only involves the actual water requirement of the rice plant, but the matter of the proper manner and distribution of its application takes into consideration the preparation of the seedbed and method of planting. Experiments at the Biggs Rice Field Station in California showed, for instance, that rice sown broadcast and immediately and continuously submerged, or sown broadcast in the water and kept submerged thereafter, appeared to mature from 7 to 10 days earlier

and to develop into better plants than rice irrigated in the old way, depending somewhat upon the date of seeding. Continuous submergence seemed to control the most common forms of water grass. When rice was drilled and immediately submerged, considerable seed appeared to rot, often resulting in poor stands and low yields. When rice was drilled or broadcasted and irrigated lightly for from 2 to 4 weeks to bring it up before permanently submerging, shallow submergence at 2 to 4 inches apparently did not control the water grass. Submergence at 6 and 8 inches aided in controlling water grass, but such depths also suffocated so much rice that low yields were produced. Good spring plowing aided materially in the control of weeds. Further experiments indicated that rice should be sown at a higher rate when it is grown by continuous submergence immediately after broadcasting than when it is grown by the old method of irrigation.

When preparing to irrigate with expensively pumped water, it is of course obviously quite important that the engineer know, with a certain degree of accuracy, the amount of water which will be required for the growth and maturity of the varieties of rice to be grown. In this connection the U. S. Department of Agriculture has established the rather general water requirement for several varieties of rice of 710 pounds of water per pound of dry matter produced. This requirement appears quite large when compared with that of other grain crops and is obviously an important factor in the cost of rice production. Such requirements should therefore be determined for the varieties of rice to be grown and interpreted in terms of actual water requirement per acre for use by the engineer.

Minimum Permissible Soil Temperature

Another quite important feature is the minimum permissible soil temperature for the varieties of rice grown, especially in the seedbed, with particular reference to the influence thereon of amount, manner, and time of application of irrigation water. Japanese experiments showed in this connection that in order to maintain warm temperatures constantly, especially in cool regions or in the spring, it was necessary that the seedbed be covered with water up to 2.3 inches in depth. With a very shallow covering, or where the soil was only saturated, soil temperatures in the seedbed were much reduced and, in cool regions especially, germination was very weak and growth decidedly slow. In warmer regions or seasons shallow irrigation was indicated, as the greater depths inhibited germination and growth. The custom of irrigating by day and draining by night was found to be often injurious.

It would seem necesary to next learn how to determine the total amount of water in addition to rainfall which will be necessary to cover the actual requirement of the rice plant and all losses due to evaporation, seepage, etc. Furthermore, a knowledge of how to control the moisture content of the soil within practical limits, with due consideration for critical periods for excessive or insufficient moisture and proper distribution during the growing season, seems to be quite important. This is emphasized by the fact that it has been found that excess or insufficient moisture at critical periods is responsible for a large proportion of the reduction from normal yields. While there is a difference of opinion as to whether or not the greatest losses are due to red rice, grass, straight head, weevils, maggots, excess moisture or insufficient moisture, it is known that in certain years from 5 to 24 per cent of the losses are due to moisture factors at critical periods. In fact, in 1913 and 1919 excess moisture at critical periods was the factor causing the greatest loss.

It is also known that evaporation, for instance, may become a very important factor in determining the total physical and chemical characteristics of soil, and particularly quantity of water necessary under certain conditions. In addition, soil type, texture, and structure, as well as the of subsoil, may be factors strongly influencing the loss of irrigation water by seepage. This opens up a field of study which has received relatively little fundamental consideration, i. e., the absorption and retention of water by soils. It is interesting to note that the Idaho agricultural experiment station is planning a study of this subject from the standpoint of increasing economy in the use of irrigation water. The economic importance of this field of study is quite evident, especially in a locality where water for irrigation must be pumped from wells.

A certain amount of data is available on the water requirements of rice, although much of it has been obtained in a purely empirical manner. For instance, on eighteen fields in the Sacramento Valley in 1918 the total amount of water applied varied from 4.27 to 14.83 acre-feet, with an average of 8.23 acre-feet. California Station Bulletin 325, Table 1, shows a net depth applied of from 3.94 to 10.94 acre-feet on different areas. The results of studies on duty of irrigation water, rainfall, and evaporation for the prairie section covering a period of 11 years were as follows: Rainfall 17.16 inches, evaporation 15.33 inches, and the amount pumped 15.74 inches.

Factors of Soil Type and Texture

Soil type and texture have an important bearing on the amount of water and the cost of irrigation. The typical soil of the Arkansas rice area consists of approximately 4 per cent sand, 69 per cent silt, and 23 per cent clay, and the subsoil is as "tight as a copper kettle". The average annual rainfall is 52 inches, but the precipitation during the rice growing season is only from 15 to 20 inches which is not enough, especially when its proper distribution is considered. A general statement made is that while 7.5 gallon per minute per acre may be taken as a standard in the design of pumps, 10 gallons may be necessary on the more porous soils, and where the subsoil is not retentive twice the so-called standard amount may be necessary. Referring again to the Sacramento valley, it was found that the duty of water was 8.12, 8.13, 9.38, and 10.94, respectively, on four typical loam areas, and 3.94, 4.22, and 5.13 on the clay and clay adobe soils. Fourteen years' experiments on the duty of water for rice irrigation in Texas by pumping showed that for prairie land the duty varied from 7.5 to 8 gallons per minute per acre. For the black clay loam or loam alluvial soils, 10 gallons of water per minute per acre was found necessary while land with a loose subsoil near a river or lake may require from 38 to 40 gallons per minute per acre. This would seem to indicate that rice soil will require water in inverse proportion to its imperviousness. This lends further emphasis to the importance of a thorough study of the influence of soil characteristics on water requirement in rice irrigation.

In the Arkansas rice area the growing season between frost dates is seldom shorter than from March 4 to November 15. The application of water extends over a period of from 85 to 90 days in these prairie fields. The ground must be submerged to a depth of from 3 to 6 inches for a period of from 60 to 90 days. As a rule the fields are not submerged until about 30 days after the plants are up, and are then kept covered most of the time until the crop is made. The fields are drained and recovered two or three times for pest control. They are leveled and levees used as checks. In recent years the tendency has been to use checks closer together with a vertical drop of from 0.3 to 0.4 feet.

The depths of wells used as the source of irrigation water in Arkansas and much of the other prairie country vary from 60 to 100 feet or more, and the average lift is probably 60 feet. The predominating style of pump used is centrifugal. This type of pump apparently has a greater efficiency and produces a greater flow than the reciprocating pump. The majority of Arkansas irrigators use three-stage centrifugal pumps. Although the efficiency of pumps is an important consideration, there is undoubtedly sufficient data of this nature available to make further experimental work on this subject unnecessary in a project of this nature. While the generally accepted water requirement is that the pump furnish 1 cubic foot per minute per acre, the important object of this work is to secure more specific data on water requirements for the area in question to insure the greatest economy in the design of pumping plants.

Friction losses, leakage, and inefficiencies in transmission make it necessary to provide about twice the theoretical power required to pump the water. If the lift, the water requirements, and the acreage are known, it should be easy

to determine the theoretical power to lift the water required at the time of maximum demand. Ordinarily if this figure is doubled it will give the actual horsepower required. It should be considered in this connection that the water table in the rice sections has been lowered perceptibly during recent years. A greater knowledge of the factors influencing the water level in wells and of the influence of variations in water level on lift and power requirement is thus obviously necessary.

The comparative costs of the various types of power are also of considerable importance. Steam, oil, and electricity are used as sources of power for pumping. Which is best and most satisfactory has not yet been determined. At first thought electricity would appear to have advantages over other types of power. However, data from preliminary experiments indicate that even with the lower cost of first installation, the acre-cost of pumping wih electric power is comparatively high. The price in Arkansas is reported as 3.5 cents per kilowatt-hour. It is by no means certain however that the cost of electricity per kilowatt-hour can not be made lower to the irrigator where from 50 to 100 horsepower units are used. On the other hand, due consideration must be given the fact that the demand for his amount of electrical energy is only from 80 to 90 days per year.

Costs Depend on a Number of Factors

Steam is increasingly expensive on account of the diminishing supply of wood, the expense connected with longer hauls, and constant attention. It is the opinion of some users that crude oil engines are the most satisfactory and lowest in cost. An analysis must thus be made of all the items involved in the use of any type of power (including fuels, lubricating oils, interest, depreciation, and repairs), however, before it can be determined with finality which is the most efficient and economical for specific conditions.

It is thus quite evident that the cost per acre for rice irrigaion by pumping will depend upon a very great number of factors. While a flat rate of from $5.00 to $7.00 per acre might be quoted for sufficient water to produce the crop in California, the type and cost of plant, acreage, capacity of well, amount of fuel needed, length of growing season, efficiency of plant, lift, variation in lift, and soil and climatological factors influence the cost of irrigating rice in the prairie section.

In summarizing this brief analysis, the following studies therefore appear to be necessary to supply the fundamental information needed to place the irrigation of rice on a more definite economic basis:

1. A cooperative study of existing weather bureau records to determine all factors of climate and weather influencing the growth of rice, and, if records are incomplete, observations to accumulate data covering the rice growing area, with particular reference to temperature ranges and amount and distribution of rainfall, especially during the growing season.

2. A cooperative study of the actual amount and seasonal distribution of water necessary for the maturity of rice, with particular reference to the determination of critical periods of excessive or deficient moisture. Also a study to determine optimum soil temperatures and minimum permissable soil temperatures for rice.

3. A cooperative study to determine the influence of variations in soil type, texture, and structure, nature of subsoil, and physical and chemical characteristics of soil and subsoil on the total water requirement of rice, with particular reference to the control of seepage and evaporation losses and the capacity to absorb and retain moisture, and also the control of excess moisture by drainage at critical periods under the physical, chemical, and biological conditions peculiar to rice soils; this to include a study of the influence of irrigation water on soil temperature and the maintenance of optimum temperatures at critical periods.

4. Studies on sources of water supply, factors influencing water level in wells, capacity of wells, factors influencing the flow of water into wells, and the geological formation of the water-bearing strata.

5. Experimental field studies in the prairie sections to determine the best field practice with reference to optimum amounts and depths of water to apply, times of aplication, time of submergence, and other factors relating to the field application of water.

6. Comparative studies of the cost of pumping, including first costs, and variable costs with steam, oil, and electricity, with particular reference to the influence of variations due to lift, insufficient capacity, labor costs, length of the season, time of maximum load, source of energy, density of population, size of units, and the like.

These would seem to be some of the more obvious major problems involved in the much needed study of rice irrigation in the prairie sections. It is possible that some problems of importance may have been omitted and that others have been mentioned which may have already been solved sufficiently for present purposes in certain localities. However, when considering all phases of the subject and all conditions of the localities in question, it would seem that these are perhaps the more important problems involved. Naturally it would be imposible for any one institution to investigate all these problems. This would therefore seem to indicate the importance of closer cooperation between the agricultural experiment stations in the southern prairie states in studies of rice irrigation, in order to bring about the most effective allocation of different phases of the work and also to prevent unnecessary duplication of effort.

The agricultural engineering department of the University of Arkansas proposes in this connection to establish a number of cooperators in the rice growing area of the state to keep accurate records of fuel consumption, attendance, flow, acreage, and capacity on steam, oil, and electric pumping plants. It is desired to determine the comparitive costs of the three sources of power for irrigaton pumping, to compare this cost with the cost of obtaining water from reservoirs, and to develop the problem sufficiently to enable the making of recommendations as to the best type, kind, and source of motive power for use in the irrigation of rice in this locality.

A bibliography of work bearing on rice irrigation and related subjects is appended for the convenience of those desiring to investigate the subject. The reference to the abstract of each report included in this bibliography as it appears in the "Experiment Station Record" is also included to aid in selecting them for use.

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(NOTE: The author of the foregoing article desires that proper credit be given R. W. Trullinger, specialist in rural engineering, U. S. D. A. Office of Experiment Stations, for preparation of the bibliography which follows, and also for revising the subject matter of the foregoing article to conform to other papers on research studies that have previously been published in AGRICULTURAL ENGINEERING.)

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Agricultural Engineering At Arkansas

THE department of agricultural engineering at the University of Arkansas is preparing material for several publications on agricultural engineering subjects. A bulletin, entitled "Tractors in Arkansas," has already been published. A bulletin is now on the press, entitled "Terracing Farm Lands," which is a concentrated simple discussion of terracing applied to Arkansas conditions. Material is in hand for publications on "Low Cost Water Systems" and "Dairy Barns for Arkansas."

None of these publications are of a technical nature as the great need at present is to make information available to farmers on agricultural engineering subjects of fundamental importance.

Agricultural Engineering Digest

A review of current literature on agricultural engineering by R. W. Trullinger, specialist in rural engineering, Office of Experiment Stations, U. S. Department of Agriculture

Specific Heats of Lubricating Oils, E. H. Leslie and J. C. Geniesse. (Industrial and Engineering Chemistry, Washington, D. C., 16 (1924), No. 6, pp. 582-583, fig. 1.) In studies conducted at the University of Michigan the specific heats of six typical lubricating oils were measured over a range of temperatures of from 37.78 to 143.33 degrees C. (100 to 290 degrees F.) An increase of from 35 to 40 per cent in specific heats was found. It is considered obvious that a change as large as this must be taken into account in engineering work. The variation of specific heats with temperature is not the same for all oils, and it is suggested that further study may disclose some connection between the temperature rate of change of specific heats and the properties of an oil as a lubricant.

An Investigation of the Fatigue of Metals, H. F. Moore and J. B. Kommers. (Illinois University Engineering Experiment Station Bulletin, 124 (1921), pp. 185, figs. 46.) Studies of the properties of ferrous metals such as are used in the moving parts of machinery of varying chemical and physical composition to determine especially the influence of repeated stress and reversal of stress upon fatigue are reported.

For the metals tested under reversed stress, a well-defined critical stress was observed at which the relation between unit stress and the number of reversals necessary to cause failure changed markedly. Below this critical stress the metals withstood 100,000,000 reversals of stress, and, so far as can be predicted from test results, would have withstood an indefinite number of such reversals. The name endurance limit has been given to this critical stress.

In the reconnaissance tests made in the field of ferrous metals, no simple relation was found between the endurance limit and the elastic limit, however determined. The ultimate tensile strength seemed to be a better index of the endurance limit under reversed stress than was the elastic limit. The Brinell hardness test seemed to furnish a still better index of the endurance limit. Elastic limits determined from compression tests and torsion tests gave no better index than did those from tension tests.

The single-blow impact tests (Charpy tests) and the repeated-impact tests did not furnish a reliable index for the endurance limit under reversed stress of the ferrous metals tested. Acceleratd or short-time tests of metals under repeated stress, using high stresses and consequent small numbers of repetitions to cause failure, are not considered reliable as indexes of the ability of metal to withstand millions of repetitions of low stress. The endurance limit for the ferrous metals tested could be predicted with a good degree of accuracy by the measurement of rise of temperature under reversed stress applied for a few minutes.

Abrupt changes of outline of specimens subjected to repeated stress greatly lowered their resistance. Cracks, nicks, and grooves caused in machine parts by wear, by accidental blows, by accidental heavy overload, or by improper heat treatment may cause such abrupt change of outline. Shoulders with short radius fillets are a marked source of weakness. Poor surface finish on secimens subjected to reversed stress was found to be a source of weakness. This weakness may be explained by the formation of cracks due to localized stress at the bottom of scratches or tool marks.

Stress above the endurance limits, due to either a heavy overload applied a few times or a light overload applied some thousands of times, was found to reduce somewhat the endurance limit of two ferrous metals tested. In none of the ferrous metals tested did the endurance limit under completely reversed stress fall below 36 per cent of the ultimate tensile strength; for only one metal did it fall below 40 per cent, while for several metals it was more than 50 per cent. However, these metals were to a high degree free from inclusions or other internal defects. The specimens had no abrupt changes of outline and had a good surface finish.

The influence of subjecting steel to a stress beyond the yield point was greater on the static elastic tensile strength than on the endurance limit, although some increase was observed for 0.18 carbon steel with polished surface after being stretched well beyond the yield point. Annealing of commercial cold drawn screw stock was found to lower its endurance limit somewhat less than it did its static elastic strength.

The results as a whole are taken to indicate the effectiveness of proper heat treatment in raising the endurance limit of the ferrous metals tested. Four appendixes are included.

An Investigation of the Fatigue of Metals, H. P. Moore and T. M. Jasper. (Illinois University Engineering Experiment Station Bulletin, Urbana, 142 (1924), pp. 88, figs. 22.) This progress report is a continuation of the preceding investigation of the fatigue of metals, which was organized in 1919 and has been carried on at the University of Illinois in cooperation with the National Research Council, Engineering Foundation, and several manufacturing firms.

The results have yielded evidence of the existence of an endurance limit for wrought ferrous metals. The tests not only failed to give evidence of damage to the metal by millions of cycles of understress but actually showed an increase of resistance to further repeated stress. This strengthening effect was most marked for those steels which are susceptible of improvement in static strength by cold working. Repeated stress at or below the original endurance limit of a wrought ferrous metal was found to raise the endurance limit for that metal. A few cycles of repeated stress above the original endurance limit lowered it. It was found that a wrought ferrous metal injured by such overstress may have its strength partly, but rarely wholly, restored by polishing its surface or by repeated stress below the endurance limit. The static strength of a wrought ferrous metal was also increased by repeated stress below the endurance limit.

Under cycles of alternate axial tension and axial compression, specimens of wrought ferrous metals gave endurance limits averaging 64 per cent of the endurance limits for the same metals under cycles of reversed flexural stress. It is recommended tentatively that the endurance limit of wrought ferrous metals under reversed axial stress be considered as 60 per cent of the endurance limit under reversed flexural stress.

The static tensile strength and the endurance limit of wrought ferrous metals were found to be lower for specimens tested across the direction of rolling than for specimens tested along the direction of rolling. Test results for a number of specimens of wrought iron and of 0.37 per cent carbon steel indicated that the effect of the direction of rolling on the endurance limit is fully as great as the effect on the static ultimate tensile strength.

Test results for 48 specimens of 0.37 per cent carbon steel cut from a 4 inch billet and subsequently heat treated indicated some relative improvement of the strength of specimens tested across the direction of rolling as compared with specimens tested along the direction of rolling.

The endurance limit and the static strength of very low carbon steel were raised appreciably by heat treatment, including a water quench, although the effect was much less marked than in the case of high carbon steels and of alloy steels. The endurance limit for cycles of reversed shearing stress for wrought ferrous metals was found to be about 53 per cent of that for cycles of reversed flexural. The data indicate further that for shearing stress the endurance limit of wrought ferrous metals for cycles of stress varying from zero to a maximum is nearly twice the endurance limit of completely reversed stress.

A statement of a theory of the fatigue of metals, which extends and modifies the generally accepted theory, is summarized in detail.

A bibliography of fifty-five references to literature is appended.

Oil Burners for Small Heating Plants, C. J. Myers. (Iowa Agricultural College, Engineering Extension Department Bulletin, Ames, 55 (1922), pp. 7, fig. 1.) The results of studies conducted at the Iowa Engineering Station on fuel oil burners for house-heating purposes are reorted.

It was found that heating with oil is more convenient than heating with coal, but that the increased convenience is usually secured at an increased cost. The gravity burner costs from $75 to $125 installed complete, while the mechanical burner costs from $450 up, but is more convenient to operate. All the fuel oil was found to be about the same in heat value, and the cheapest oil which a burner will consume satisfactorily is considered to be the most economical. It is stated that at present prices the cost of heating with coal and oil is about the same in the central part of Iowa.

Relation of Temperature and Pressure to the Absorption and Penetration of Zinc Chloride Solution into Wood, J. D. MacLean. (American Wood Preservers' Association Proceedings, 20 (1924), pp. 44-71, figs. 8.) Studies conducted by the U. S. D. A. Forest Products Laboratory are reported which showed that high solution temperatures are very effective in improving the absorption and penetration of zinc chlorid in wood. There is a limit above which the temperature-pressure combi-

nation should not go if collapse is to be avoided. This limit is apparently higher for large pieces than for small ones, and higher for some species than others.

It is believed that the use of high temperatures in zinc chlorid treatment will not only result in better treatment but will bring about considerable saving in cost of operation by shortening the time of treatment, or by eliminating steaming.

Tests of a Potato Digging Machine and Estimation of the Speed Relations of the Digging Mechanism, T. Rudzki. (Roczniki Nauk Rolniczych, Posen, Poland, 10 (1923), No. 1, pp. 52-82, figs. 13.) The result of an analytical and graphical study and actual field tests of a potato digging machine employing digging forks operating at right angles to the forward direction of the machine are reported. Parallel operation of the forks gave the best results, since the speed of any fork was never greater than the point at which it is fastened on the throwing axle.

The maximum throwing speed was found to be about 4 meters (13.12 feet) per second. The forks removed a parallelogram of soil the sides of which formed an angle with the direction of movement of from 14 to 16 degrees. Thus the reaction of the fork movement could be determind with reference to its influence in increasing the draft of the machine. The average angle of removal of the soil and potatoes was approximately the same as the angle of inclination of the sides of the parallelogram of soil removed. A heavy inclination of the fork axle toward the horizontal was found to be favorable to operation.

Transmission of Heat Through Building Materials, F. B. Rowley. (Minnesota University, Engineering Experiment Station Bulletin, Minneapolis, 3 (1923), pp. VI 74, figs. 45.) The results of a series of tests on insulating materials and building construction are reported. The object of this work was (1) to develop an improved method for testing insulating and building materials which would eliminate some of the uncertain heat losses in methods commonly in use, (2) to determine the insulating value of certain classes of insulating material now on the market, and (3) to determine the insulating value of these materials as applied to practical building construction.

Insulating materials are tentatively classified as those used for insulation only, those used for insulation in combination with a plaster base, and those which may be used as either an insulating material or as a plaster base. In general, it was found that the lighter and more loosely matted the material the better is its insulating value. There was a variation in thickness and density of such materials, with a corresponding variation in insulating value. Materials of the same manufacture may vary in their thermal properties, and in some cases where one material shows a transmission constant slightly above or below a second material the samples might be so selected that the results would be reversed. Differences as high as 20 per cent were noted. Materials which were loosely matted and stitched between two layers of paper showed the greatest variation in thickness and in insulating value. A comparison of the tests made with and without plaster on the face of insulating materials showed that the insulating value of the plaster is very low, decreasing the transmission constant from 2 to 4 per cent.

Details of tests of wall sections are presented, and the method of calculating heat losses is outlined. The results show conclusively the value of insulating material as applied to wall construction.

Studies on the Biology of Sewage Disposal, W. Rudolfs et al. (New Jersey Station Bulletin, New Brunswick, 390 (1923), pp. 3-78, figs. 33.) A series of studies conducted in co-operation with the New Jersey State Department of Health on the biology and biochemistry of sewage disposal are reported. These included, chemical, protozoological, botanical, bacteriological, and practical studies.

Studies by F. L. Campbell and W. Rudolfs on Imhoff tanks at Plainfield, North Plainfield, and Dunellen, New Jersey, in which attention was centered on sludge digestion, indicated that the contents of sludge digestion chambers are stirred up during operation by increasing gas evolution. For several weeks fresh solids come in faster than they can be digested. Resting allows a tank to catch up in its digestion. Free ammonia determinations on the liquid and sludge of operating and resting tanks showed that the diffusion of ammonia out of the digestion chambers takes place fast enough to account for the greater ammonia content of the effluent over that of the influent. H-ion concentration values showed, however, that the effluent of a tank is always less alkaline than the influent. It is thought that some acid compound must diffuse out of the digestion chambers also. No nitrites or nitrates have as yet been found in liquid or sludge to indicate the presence of nitrifying organisms. Analyses of gases from sludge digestion showed that the gas composition was fairly constant in weekly samples from one gas vent over a two-month period. No hydrogen was found. Gas collected from sludge alone 17 feet below the surface of the vent showed less carbon dioxid than samples collected at the surface. The carbon dioxid content decreased from the inlet to the outlet end of a tank.

Studies on chemical changes in three layers of the Plainfield sprinkling filter beds showed that sampling from pipes which tapped the bed was the best method possible without building a special experimental bed, but that the samples were often not representative because the volumes were not constant. The results showed that the greater part of the effective nitrification takes place at the bottom of the bed throughout the whole year. It is believed that old solids which collect at the bottom offer a large active surface for the sewage flowing through them and so are responsible for the nitrification at the bottom. The analogy between these solids and activated sludge is pointed out. Denitrification was found to exceed nitrification in the upper parts of the bed in the spring just before the accumulated solids pass out. Free ammonia was found to be removed chiefly at the bottom of the bed, and ammonia formation in the bed often obscures the decrease in ammonia originally present in the influent as it passes through the bed.

Studies on the fauna of the sprinkling filter bed and Imhoff tanks by L. A. Hausman dealt with the numerical and seasonal status of the lower animals present. The results showed that the free-moving forms, such as the free swimming ciliates and worms, increase in numbers as the film on the stones builds up, and that during the slough these pass out with the filter effluent along with the sloughing film. It is noted that just before sloughing begins the nematodes and annelids begin to increase. The growth of Opercularia, the stalked fixed protozoan form, increase greatly after the sloughing is over and when the film from the stones is removed. It is considered probable that this form may be important with reference to its excretions into the filter bed. A considerable assemblage of organisms was found in the influent and effluent of the Imhoff tanks, and these together with the wind-blown dust, are considered to be the probable sources of the population in the filter beds.

Studies of the fungi and algae of the sprinkling filter bed, with special reference to their seasonal distribution, by C. M. Haenseler, W. D. Moore, and J. G. Gaines, are also reported. These included an examination of the slimy film on the stones of a sewage filter bed conducted over a period of sixteen months to determine the relative abundance and seasonal fluctuation of fungi, algae, and filamentous bacteria. The surface layer of stones was found to be covered throughout the year with an abundance of green alga, Stigeoclonium, and the blue-green alga Oscillatoria. A relatively small amount of fungi was present on the surface stones. On the subsurface stones the slimy film was bound together largely by fungi, Beggiatoa, filamentous bacteria, and stalked protozoa. The principal fungi found in the mycelial stage were Penicillium sp., Pythium sp., Dictyuchus, and two unidentified forms. There was a seasonal fluctuation of the fungi, reaching a maximum during the winter months and a minimum during June, July, and August. Beggiatoa and the filamentous bacteria had a seasonal fluctuation opposite that of the fungi, reaching a maximum during the summer and a minimum during the winter. Fungus hyphae seemed to play an important role in building up and binding together the film on the subsurface stones of the filter bed.

Bacteriological studies on the Imhoff tank and sprinkling filter bed by M. Hotchkiss included a survey during the period from November, 1922, to April, 1923, of bacteria responsible for certain biochemical changes. These included proteclytic organisms, organisms responsible for sulphur reduction and oxidation, those concerned with nitrogen transformation, and those causing the destruction of cellulose. The bacterial population of both Imhoff tanks and sprinkling filters was found to be similar during the winter months, and the groups of organisms bore approximately the same numerical relationship. Of the types studied, those present in the highest dilutions of the inoculum were the proteolytic bacteria and the bacteria concerned with the transformation of nitrogen. The nitrate reducing organisms were somewhat more abundant than the nitrogen oxidizing organisms in both the sprinkling filter and the Imhoff tank. The bacteria concerned with sulphur changes were less abundant than those concerned with the nitrogen cycle, while cellulose destroyers were found only in the low dilutions. The variation in numbers of nitrogen reducers and oxidizers was the same during the period. In general, an inverse ratio existed with the nitrogen oxidizers present in large numbers at first and then decreasing, while the nitrogen reducers increased in numbers during the winter months.

Observations on tanks in the resting condition showed that approximately the same distribution of organisms occurred as in tanks in operation. The length of the incubation period was found to be an indication of the ease with which the different substances were attacked by the bacteria. During the six-month period bacteria which produce exidation changes were present in the Imhoff tanks, while those which produce reduction changes were also found in the sprinkling filter. These results are taken to indicate that it is not wholly correct to designate Imhoff tank purification as anaerobic digestion or the sprinkling filter as a purely oxidizing agency.

Plant and laboratory experiments on the initial dewatering of sludge with aluminum sulphate to hasten air-drying on beds by Rudolfs, J. R. Downes, and Campbell, are also briefly reported.

A list of twenty-one references to works bearing on the subject is included.

News Section

Special Tractor Meeting

AS a result of a conference held in Chicago, January 28, between representatives of the American Society of Agricultural Engineers and the Society of Automotive Engineers, a special cooperative two-day tractor meeting will be held at the Great Northern Hotel, Chicago, April 29 and 30, 1925.

The Farm Power and Machinery Division of the American Society of Agricultural Engineers will have entire charge and be responsible for the program of the first day, April 29, which will be devoted entirely to the agricultural application of the internal-combustion tractor. The program for the second day of the meeting, April 30, will be arranged and put on by the Society of Automotive Engineers. This program will deal with internal-combustion engineering as applied to tractors; in other words, to strictly engine problems.

For the A. S. A. E. program on the first day two major and two minor topics have been selected for discussion. The two major topics are the power-take-off and related problems and tractor lugs and related problems in soil dynamics. The two minor topics include some problems in tractor research and tractor belt speeds .

A program for the evening of April 29 is being arranged by the American Society of Agricultural Engineers which will be a get-together for the benefit of engineers and others attending the meeting, at which time will be put on a special entertainment feature consisting of motion picture films, including a very complete film on the production processes in one of the large tractor manufacturing plants of the country, and several films showing the agricultural application of the tractor. Through the courtesy of the Western Society of Engineers its assembly rooms in the Monadnock Building have been made available for showing the motion picture films.

A special noonday luncheon will feature the session of both days. Each society will have charge of the luncheon on the day on which its program is presented.

Dynamometers Available For Testing

IN the October 1924 issue of AGRICULTURAL ENGINEERING announcement was made of the fact that through the courtesy of the General Motors Research Corporation three pieces of experimental testing apparatus had been placed at the disposal of the American Society of Agricultural Engineers to be allocated to state or federal institutions engaged in agricultural-engineering research.

Any institution desiring the use of this apparatus should make application to the Secretary of the Society or the chairman of the Research Committee.

The apparatus consists of a Watson dynamometer arranged for recording draft up to 6,000 pounds, a Hyatt recording hydraulic dynamometer, and a small dynamometer car arranged to accomodate the Hyatt dynamometer. The Hyatt dynamometer is now in the hands of one of the agricultural experiment stations where it will be used in connection with tractor tests in the spring. The Watson dynamometer is still available to any institution which desires to take advantage of the generous offer of the General Motors Research Corporation.

The chairman of the Research Committee desires it to be understood that he will be glad to receive requests for the use of this apparatus from any institution that honestly desires to use it.

Personals

H. B. Bonebright, Chinook, Montana, in addition to operating his 160-acre irrigated ranch, is also president and superintendent of construction of the Belknap Irrigation and Canal Company, a member of the executive board of the Upper Milk River Irrigation District, consulting engineer for the Fairway Farming Association (Rockefeller Foundation), a member of the executive board of the Blaine County Farm Bureau, president of the Blaine County Farmers' Union, and at present is in charge of the Blaine County Gas Engine and Automobile School at Chinook. Mr. Bonebright was formerly professor of agricultural engineering at the Montana Agricultural College, and is one of the first members of the Society.

Deane G. Carter is author of "Terracing Farm Lands", (Extension Circular No. 182), just issued by the agricultural extension service of the University of Arkansas. It is devoted chiefly to laying out, building, and maintaining terraces to prevent soil erosion.

Geo. S. Knapp, state irrigation commissioner of Kansas, is to be congratulated on his report to the Kansas State Board of Agriculture for the biennium July 1, 1922 to June 30, 1924, which is a detailed and interesting report of irrigation work in Kansas during that period. The third chapter of this report contains the paper entitled "The Irrigation Problem in Kansas", presented by Mr. Knapp at the eighteenth annual meeting of the American Society of Agricultural Engineers at Lincoln, Nebraska, June 1924.

American Engineering Standards Committee

A. E. S. C. Elects Officers

AT the annual meeting of the American Engineering Standards Committee on December 11, Charles E. Skinner, a representative of the American Institute of Electrical Engineers, was elected chairman for the year 1925, and Charles R. Harte, representative of the American Electric Railway Association, was elected vice-chairman.

The other members of the executive committee for the year 1925 are as follows:

Ralph G. Barrows, U. S. War Department
Geo. K. Burgess, U. S. Department of Commerce
John A. Capp, American Society for Testing Materials
Coker F. Clarkson, Society of Automotive Engineers
W. A. E. Doying, The Panama Canal
Stanley G. Flagg, Jr., American Society of Mechanical Engineers
E. A. Frink, American Railway Association—Engineering Division
C. S. Gillette, U. S. Navy Department
O. P. Hood, U. S. Department of Interior
Sullivan W. Jones, American Institute of Architects
Thomas A. McDonald, U. S. Department of Agriculture
Charles A. Mead, American Society of Civil Engineers
A. H. Moore, Electrical Manufacturers Council
A. Cressy Morrison, Gas Group
Dana Pierce, Fire Protection Group
F. L. Rhodes, Telephone Group
S. G. Rhodes, Electric Light and Power Group
C. F. W. Rys, Association of American Steel Manufacturers
Ethelbert Stewart, U. S. Department of Labor
Geo. C. Stone, American Institute of Mining Engineers
Albert W. Whitney, Safety Group

Developments in Industrial Standardization During 1924

NOTABLE developments in the industrial standardization movement, including important progress in the mechanical and mining industries, and in the safety field, its further extension into managerial and trade association activities both here and in Europe, and steps looking toward it in Latin America, have taken place during 1924, according to an announcement of the American Engineering Standards Committee.

Most of the great firms are now coming to have some definite organization for their standardization work. Increasing competition is bound to result in some form of definite organization for the work in the majority of all but the smallest companies. This has already taken place in Germany, where more than one thousand firms have such organizations. The increase in the number of associations and companies affiliated in the membership of the American Engineering Standards Committee is a notable step in this direction.

This interest on the part of management is shown by the fact that standardization is becoming one of the most important and appreciated activities of trade associations, which are the principal mechanism through which management arrives at collective industrial policies. For example, one hundred and fifty trade associations are officially participating in the work of the A. E. S. C. through accredited representatives.

In all, about seventy standards have been approved by the

American Engineering Standards Committee, and one hundred others are under way. Of these, thirty-two have to do with civil engineering and the building trades: twenty-six with mechanical engineering; fifteen with electrical engineering; four with automotive subjects; eleven with transport; one with ships and their machinery; fourteen with ferrous metals; fifteen with non-ferrous metals; twelve with chemical subjects; two with textiles; sixteen with mining; five with the wood industry; one with the paper and pulp industry; and eleven projects with topics of a miscellaneous or general character.

The most important piece of work completed by the A. E. S. C. in the mechanical field during 1924 was the promulgation of the standard for screw threads, a subject which touches practically every industry. This was worked out in cooperation with the National Screw Thread Commission. Good progress has been made in two other far-reaching subjects: gauges and systems of gauging and pipe flanges and fittings. Parts of the work on both of these subjects are now nearly ready and will be issued soon.

Work on dimensions and tolerances for nuts and bolts is also well advanced. At an informal conference of representatives of the American, Czechoslovakian and German committees, it was recommended that there be held a general international conference looking toward international agreement so that there may be international interchangeability in regard to wrenches, nuts and bolt heads.

Technical standardization is playing an increasing role in matters of safety. Important examples of such work in connection with public safety is that of the A. E. S. C. on the unification of colors for traffic signals, and on a code for automobile brakes and brake testing. The importance of the general problem was summarized by Herbert Hoover in the statement that the number of fatalities, 22,600, is one-third as great as the corresponding American losses in the war.

The Federal Specifications Board has now adopted nearly three hundred specifications. These are used as a basis of purchase throughout the federal government. The A. E. S. C. has continued its cooperation in this work, and during the year has circulated more than one hundred of these specifications for criticism, in order to determine their acceptibility in industry before official adoption by the government.

The third year of the work of the Division of Simplified Practice of the Department of Commerce has shown extensive development. In all, twenty-six simplifications have already been carried through, ten others are in the final stages, and forty-five additional surveys are now under way. Two hundred industrial groups are cooperating in the various projects.

The U. S. Chamber of Commerce and the A. E. S. C. are cooperating closely in this work. In general, Mr. Hoover's Division concentrates upon such eliminations as it is possible to carry out from a survey of statistical production data alone. An exception to this is the work which has been carried out on standardization of lumber sizes and grading rules for soft woods, which constitute the Division's most notable achievement.

The work on the "Dictionary of Specifications", being carried out by the Bureau of Standards and the Bureau of Foreign and Domestic Commerce, is nearly ready for publication. This will consist of a classified list of all of the more important purchase specifications in existence in this country. It has been carried out primarily for the use of public purchasing bodies, to which, as well as to industries in general, it should be of great service.

The cooperation of the federal government with industry through the machinery of the A. E. S. C. steadily increases; in fact, one or more arms of the government are cooperating in nearly every one of the A. E. S. C. projects. The Bureau of Standards and the Federal Specificaions Board jointly maintain a liaison officer in A. E. S. C.

New A. S. A. E. Members

Albert E. Backman, assistant engineer appraiser, Federal Land Bank, Berkeley, California.

Alfred Boock, mechanical engineer in charge of farm engines, Fairbanks, Morse & Company, Beliot, Wisconsin.

Frederick W. Jones, contact man on machinery advertisers accounts, Western Advertising Agency, Racine, Wisconsin.

Charles M. Packham, factory representative for manufacturers' sales, The Bassick Manufacturing Company, 2650 North Crawford Avenue, Chicago, Illinois.

John Stanley Winters, instructor in agricultural engineering, University Farm, Davis, California.

TRANSFER OF GRADE

S. Stanley Graham, associate professor of agricultural engineering, Sam Houston State Teachers College, Huntsville, Texas. (From Junior Member to Associate Member.)

Willis S. Rosing, Osceola High School, Osceola, Iowa. (From Student to Junior Member.)

Franklin J. Zink, assistant engineer, Iowa Engineering Experiment Station, Ames, Iowa. (From Student to Junior Member.)

Applicants for Membership

The following is a list of applicants for membership received since the publication of the December issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send information relative to applicants for the consideration of the Council prior to election.

Frank Adams, professor of irrigation investigations and practice, University Farm, Davis, California.

Herman F. Bahmeier, ranch superintendent, Cantil, Kern County, California.

Archibald Douglas Bell, illuminating engineer, Edison Lamp Works of General Electric Company, Harrison, New Jersey.

William Burd Condit, superintendent, E. W. Ross Company, Springfield, Ohio.

LeRoy Collier Hart, engineer and designer, Monroe, Georgia.

Martin J. Lefler, foreman in foundry, Union Malleable Iron Company, East Moline, Illinois.

Nels Conrad Magnusan, hydrographer, Texas Board of Water Engineers, Austin, Texas.

A. Mollayan, sales engineer, United Machines, Tire & Rubber Works, New York City.

L. A. Paradise, superintendent of experiments, John Deere Harvester Works, East Moline, Illinois.

TRANSFER OF GRADE

John Thomas McAlister, department of agricultural engineering, Clemson College, South Carolina. (From Associate Member to Member.)

William H. Tague, teacher, Marion Township High School, Marion, Illinois. (Student to Junior Member)

A. S. A. E. Employment Service

This service, conducted by the American Society of Agricultural Engineers, appears regularly in each issue of Agricultural Engineering. Members of the Society in good standing will be listed in the published notices of the "Men Available" section. Nonmembers as well as members, are privileged to use the "Positions Available" section. Copy for notices should be in the Secretary's hands by the 20th of the month preceding date of issue. The form of notice should be such that the initial words indicate the classification. No charge will be made for this service.

Men Available

AGRICULTURAL ENGINEER, 1923 graduate of Kansas State Agricultural College in agricultural engineering, desires to make a change. Work along engineering lines is preferred. Address M. S. Cook, 5406 Ferdinand Street, Chicago, Illinois. MA-121.

AGRICULTURAL ENGINEER with experience on large farms with all kinds of machinery and equipment wants position with manufacturer of farm equipment. MA-122.

AGRICULTURAL ENGINEER wants position with contractors doing work in farmstead planning and building. MA-123.

AGRICULTURAL ENGINEER open for position as sales engineer, salesman, advertising writer, or agricultural propagandist. Past experience with large agricultural firms. MA-124.

Positions Open

AGRICULTURAL ENGINEER equipped with good training and experience in agricultural engineering, preferably familiar with New England agriculture, is wanted by state agricultural experiment station in one of the New England states, to take charge of experimental work on rural electrification projects. Write the Secretary of the American Society of Agricultural Engineers.

CIVIL SERVICE OPENINGS

The U. S. Civil Service Commission announces a competitive examination for "assistant reclamation economist," on March 11, to fill vacancy in the reclamation service, Department of the Interior, for duty in the field. The entrance salary for this position is usually $1800.00 a year, but appointments may be made at higher salaries, up to $3000.00 a year, if the qualifications of the appointee so warrant. The duties consist of field work in studying the suitability of arid lands for irrigation; analysis of irrigated farms for cost of production, etc.; and assisting in the economic surveys of irrigation projects. Competitors will be rated on practical questions, a thesis to be written in the examination room, and education and experience.

For full information on civil service openings and application blanks write the U. S. Civil Service Commission, Washington, D. C., or the Secretary of the Board of U. S. civil-service examiners at the post office or custom house in any city.